Addressing Technical, Legal and Diplomatic Obstacles To Combatting Human Trafficking Using DNA Databases Across National Boundaries

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Abstract

Using DNA to combat human trafficking and identify missing persons across borders is not only a data analysis challenge, but a complex legal and diplomatic issue. Barring criminality, most people have the right to be "missing," and may have valid motives to stay hidden. A political issue is that many nations are not inclined to share data with investigators in other countries under principles of sovereignty and protecting the privacy of their own citizens. Child trafficking was the common ground to break down barriers to collaboration, since most societies agree that the State has a compelling interest in the welfare of children. The Latin American migratory corridor has been an initial focus. Many computational obstacles to large-scale, DNA-based identification of missing persons were addressed more than fifteen years ago with the 9-11 attacks. 2749 people from 90 countries were killed at the World Trade Center;[1] Most of the identified were named via kinship analysis, using DNA from multiple family members. That technology has been repurposed to investigate missing persons cases, to fight human trafficking, and for general criminalistics.[2, 3] Over the last two years, resources have focused on creating harmonized, collaborative, independent DNA databases to investigate los desaparecidos and trafficked persons across Latin America and into the Southern USA. The ***DNA-ProKids*** project at **University of Granada** set standards that have been applied to efforts in countries including Peru, Panama, Costa Rica, Honduras, Guatemala, El Salvador and Mexico.

Technologies Used in Human Identification

"DNA Fingerprinting" measures fragment lengths of autosomal Short Tandem Repeats [**STR**'s], typically tetra- and penta-nucleotides (Fig 1). Additional maternal lineage data is analyzed from **primary mtDNA sequence** and paternal lineage from **Y-STR**'s. Panels of **SNPs** (Fig 2) add additional discriminating power. For each assay, allele and haplotype frequencies are measured in relevant populations to measure statistical significance of a match. Matches can be "**direct**," matching the profile of an unknown person to a known sample (Figs 1 and 2), or "**indirect**," using **kinship analysis** to compare the profile to known relatives of individuals (Fig 3).[4]

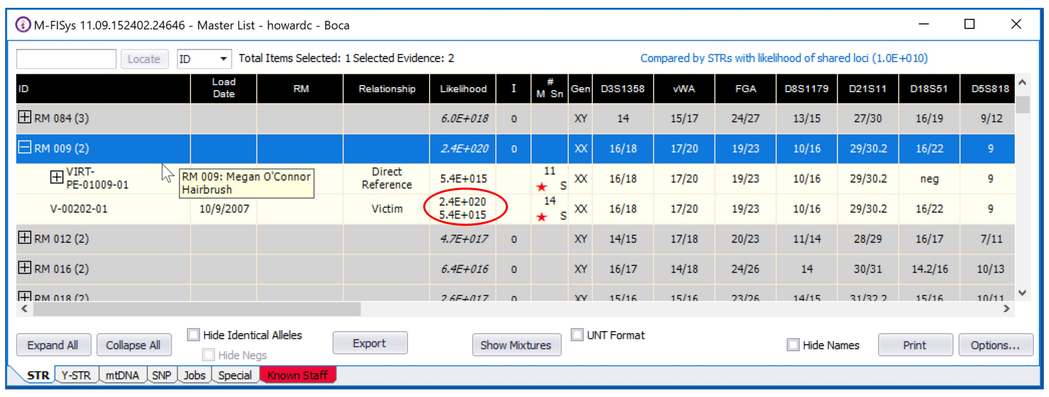


Figure 1. Direct match of STR from an unidentified person to a reference profile from a hairbrush. The likelihood of seeing this profile is the product of the likelihood (inverse of the frequency) of each probative locus = 5.4×10^{15}.

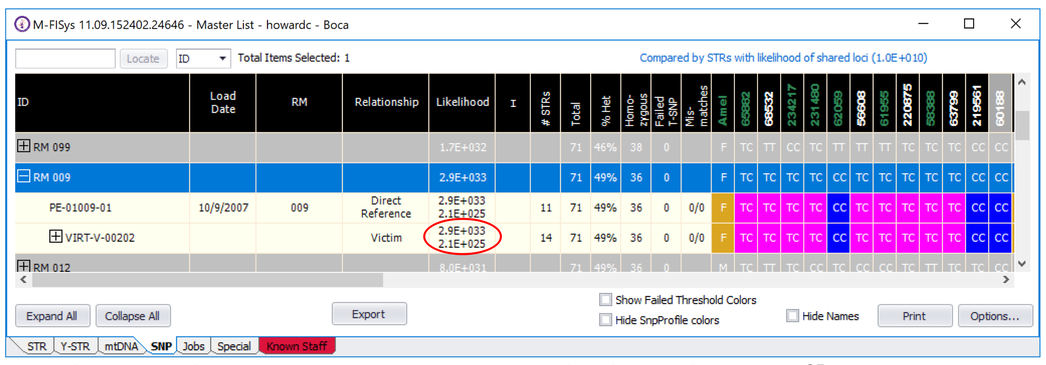


Figure 2. Direct match of 71 SNP panel. Likelihood is 2.1×10^{25}. Because the loci are independent and unlinked, the STR and SNP likelihoods can be multiplied together.

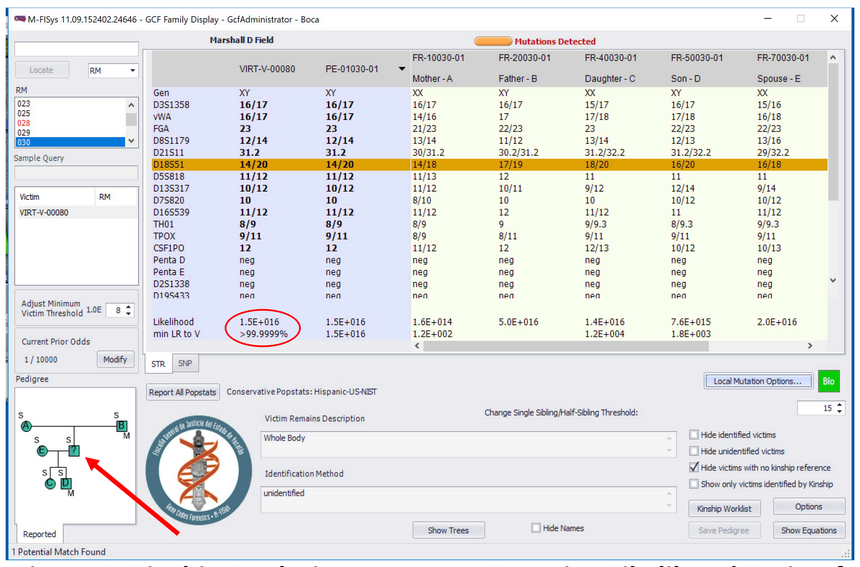


Figure 3. Kinship Analysis computes a Bayesian Likelihood Ratio of the combined likelihood of all the relationships in a complex pedigree, divided by the likelihood that the same shared alleles might be found in a random person in the same ethnic group.

Overcoming Political / Social Obstacles

When an unknown person, living or dead, is found and might be from a foreign country, international collaboration is diplomatically challenging and sometimes prohibited by statute. One solution is implemented in the M-FISys® (pronounced like *"emphasis"*) database and program [Gene Codes Forensics, Ann Arbor, USA]: It is called the *Confidential Search File*. In the simplest use, profiles of unidentified individuals can be selected from the local M-FISys database. All identifying metadata is stripped and profiles are packed into an (**AES 256-bit**) encrypted file which can be sent to the collaborating laboratory. Upon comparison, the receiving lab cannot view or import the data, but is only told which, if any, direct references or pedigrees in their own database match the contributed material (identified only by originating lab and sample name). From there, diplomats negotiate data exchange without any other profiles being revealed.

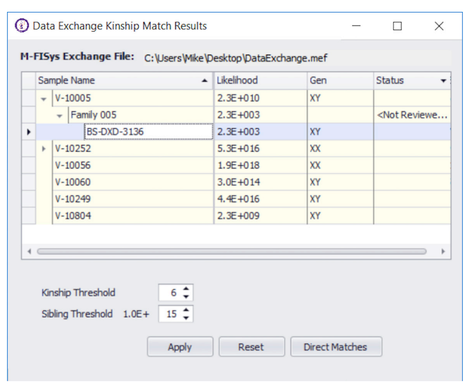
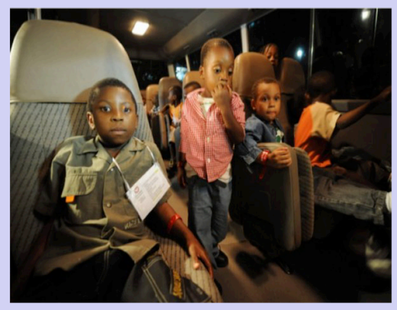


Figure 4. Confidential Search File finding a match between submitted profile V-10005 and this laboratory's pedigree for family #005 (only a single sibling) with a likelihood ratio of 2.3×10^3.

Interdicting Child Trafficking In the Real World

As of this writing, 62 M-FISys seats have been installed around the world. The following case describes a use of DNA-ProKids protocols that did not involve the M-FISys database. (Haiti is not an M-FISys site.)



A catastrophic, magnitude 7.0 earthquake struck Haiti on 12 January 2010, with an estimated 100,000 fatalities. In May of that year, Bolivian border police became suspicious of a relief flight bringing 25 traumatized Haitian children on a respite vacation to South America. DNA testing quickly matched 13 of the children to pedigrees from families looking for them in Haiti. Smugglers had snatched the children for intended sex trafficking to Brazil and Argentina.[5] Such cases partly motivated the US Congress to identify and promote a standardized, confidential mechanism for DNA data exchange between nations to fight human trafficking. We welcome all bioinformatics scientists interested in contributing to this important work.

Acknowledgments

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